# Yerington Anaconda Mine Site

## *Enhanced Evaporation Pilot Test Results*
## *DRAFT FOR DISCUSSION*

*Oct 20, 2015*

SPSIII

preliminary for discussion – final results will be provided in the final report



ED_001725B_00102444-00001

# Meeting outline

- Summary
- Work plan
- Design & construction
- Startup & operations
- Test results
- Full-scale considerations
- Conclusions
- Discussion

# Summary

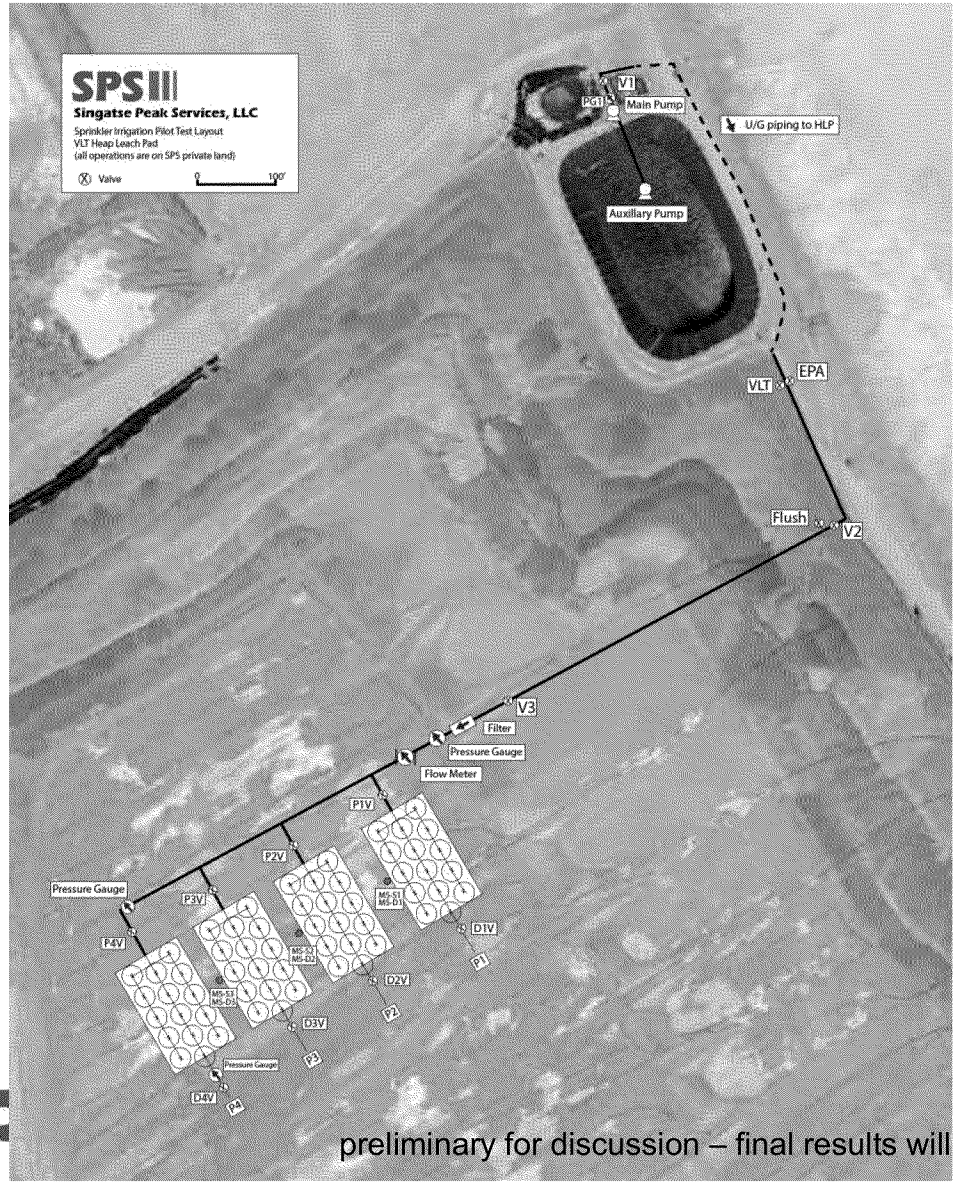
EE pilot was successful in collecting empirical data for design of a full scale system

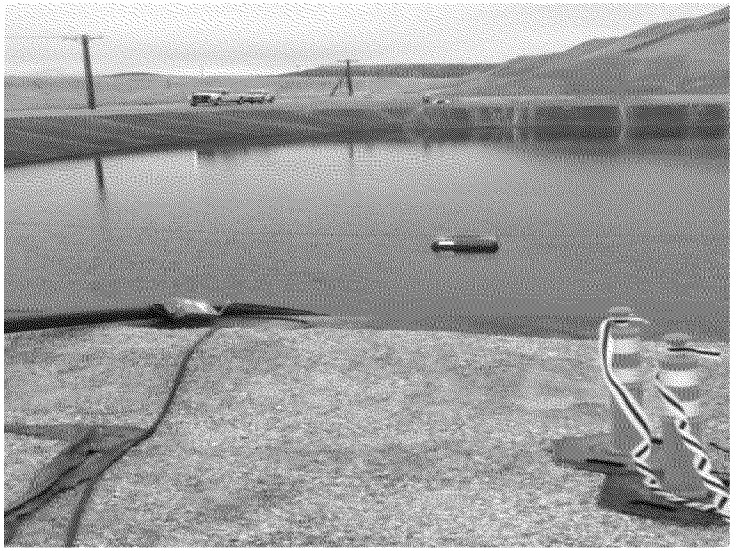
- Extend the life of the FMS by 10 yr
- No net accumulation of fluids (est 1.5M gal/yr)
- Low maintenance
- Cost effective
- Could be scaled to eliminate all fluids as part of long term remediation of ponds

# Work plan

- Objective of pilot was to obtain empirical data for design of a full scale system that would:
  - Extend the life of the FMS by 10 yr
  - No net accumulation of fluids
- Performance criteria
  - Water balance
  - Low maintenance
  - Cost effective
- Changes from the work plan
  - Irrigation approach only (did not test water truck)
  - Moisture sensors were not effective

# Construction layout



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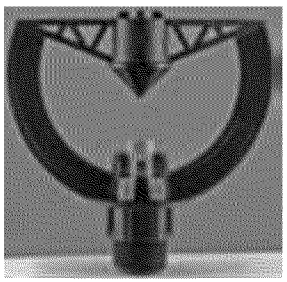
# Bete sprinkler heads

- Stainless steel
- Excellent chemical resistance
- No moving parts
- High evaporative efficiency
- Minimal (no) clogging
- Maintenance free



Senninger heads less efficient

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# Design & construction

- Layout, survey, level test area
- Sprinkler pressure 30-40 psig, pump outlet 120 to 140 psig
- Pumps
  - Durco (25 hp)
  - New auxilliary (13 hp)
- Piping
  - Existing 4 inch on HLP/liner, and underground
  - New SDR 11 elsewhere, pumps, other connections
  - New manifold/panel (2 in. laterals, 1 in. PVC risers)
  - Pressure test
- Monitoring – flow meter and pressure gages
- Moisture sensors were not effective
- In-line filter was key improvement

# Overview of pilot test results

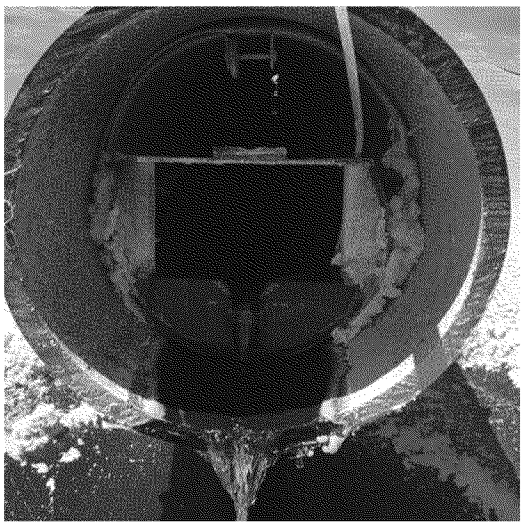
- Fluid pumping results (see excel spreadsheet)
  - 4 months, 88 operating days
  - 942,500 gal pumped
  - Ave 10,710 gal/day, 122 gpm
- Potential recirculation
- Total Dissolved Solids (TDS)
- Estimate of Evaporation – natural and enhanced
- Water Balance
  - Update by ARC in 2016 FMS O&M report

# Evaluation of potential recirculation

| 2015 Flow and Precipitation Data | | | | |
|---|---|---|---|---|
| Month Ending | Precip (in) | VLT (gpm) | Slot (gpm) | Ph III (gpm) |
| 1/31/2015 | **0.25** | 2.95 | 2.14 | 3.43 |
| 2/29/2015 | **0.25** | 2.85 | 2.50 | 1.96 |
| 3/31/2015 | **0.25** | 3.17 | 2.39 | 1.83 |
| 4/30/2015 | **0.25** | 2.57 | 2.29 | 2.11 |
| 5/31/2015 | 1.73 | 3.01 | 5.10 | 4.40 |
| 6/30/2015 | 1.04 | 3.36 | 4.00 | 3.48 |
| 7/31/2015 | 0.61 | 2.82 | 3.71 | 3.10 |
| 8/31/2015 | 0.26 | 2.97 | 3.49 | 3.19 |
| 9/30/2015 | 0.00 | 2.51 | 3.02 | 2.74 |
| 10/31/2015 | 0.78 | 2.47 | 2.64 | 4.89 |
| 11/30/2015 | 1.29 | 5.60 | 5.04 | 6.51 |
| 12/31/2015 | 0.27 | 4.50 | 3.32 | 3.87 |
| **Annual total (in)** | **6.98** | **3.23** | **3.30** | **3.46** |

| 2016 Flow and Precipitation Data | | | | |
|---|---|---|---|---|
| Month Ending | Precip (in) | VLT (gpm) | Slot (gpm) | Ph III (gpm) |
| 1/31/2016 | 0.99 | 3.38 | 3.62 | 2.77 |
| 2/29/2016 | 0.21 | 4.32 | 5.15 | 4.78 |
| 3/31/2016 | 0.17 | 2.81 | 2.74 | 2.47 |
| 4/30/2016 | 0.71 | 3.05 | 3.32 | 3.9 |
| 5/31/2016 | 1.02 | 3.42 | 3.05 | 4.97 |
| 6/30/2016 | 0.00 | 2.92 | 2.36 | 2.23 |
| 7/30/2016 | 0.00 | 3.01 | 2.27 | 1.50 |
| 8/31/2015 | 0.00 | 2.32 | 2.32 | 2.47 |
| 9/30/2016 | 0.00 | 2.41 | 1.66 | 1.90 |
| 10/31/2016 | | | | |
| 11/30/2016 | | | | |
| 12/31/2016 | | | | |
| | **3.10** | **3.07** | **2.94** | **3.00** |

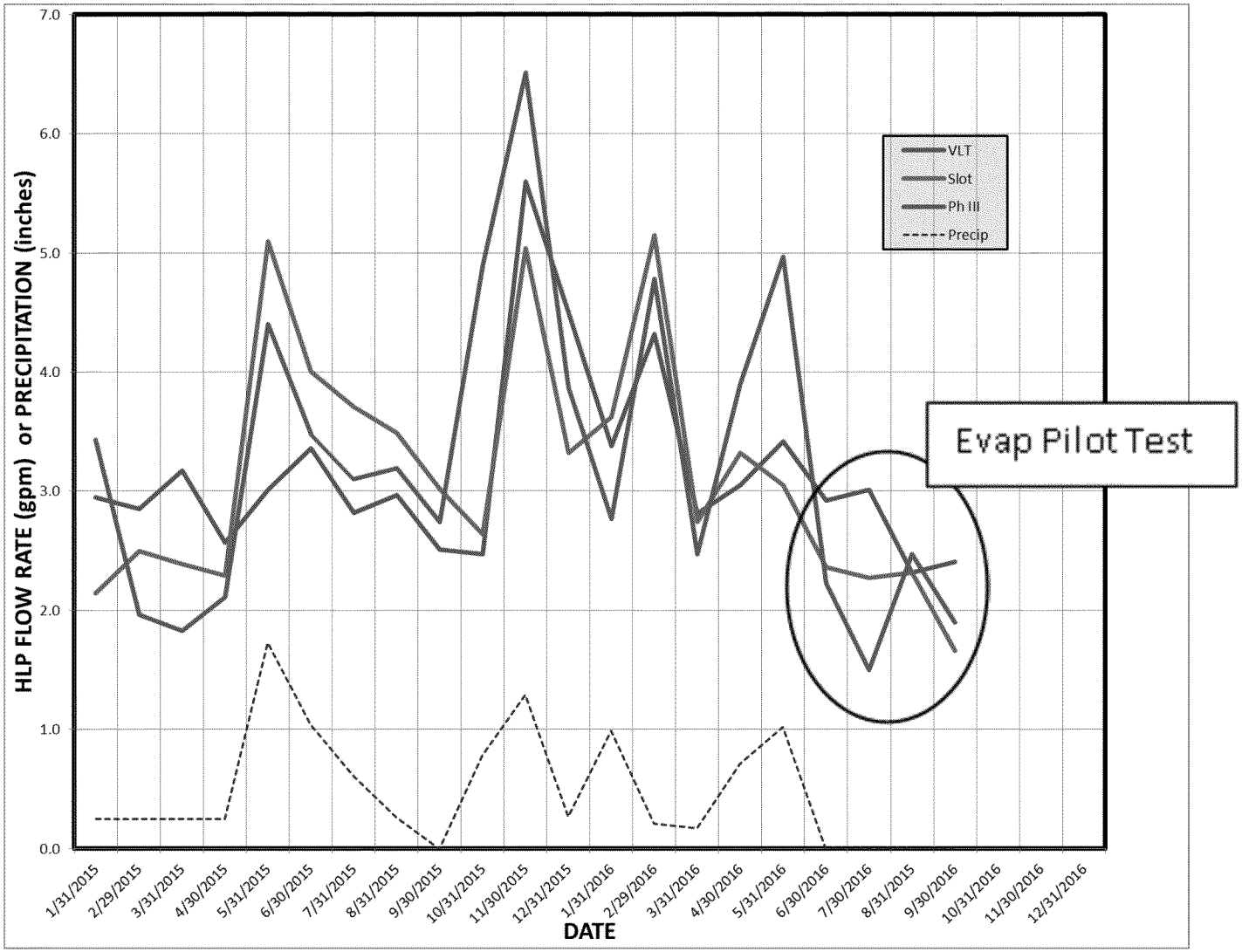
- Weir flow measurements
- Comparison of 2015 & 2016 flows
- VLT HLP
- Slot and Ph III HLPs
- Precipitation effects
- Leak detector data



SPS III

preliminary for discussion – final results will be provided in the final report

# Monthly weir flow data

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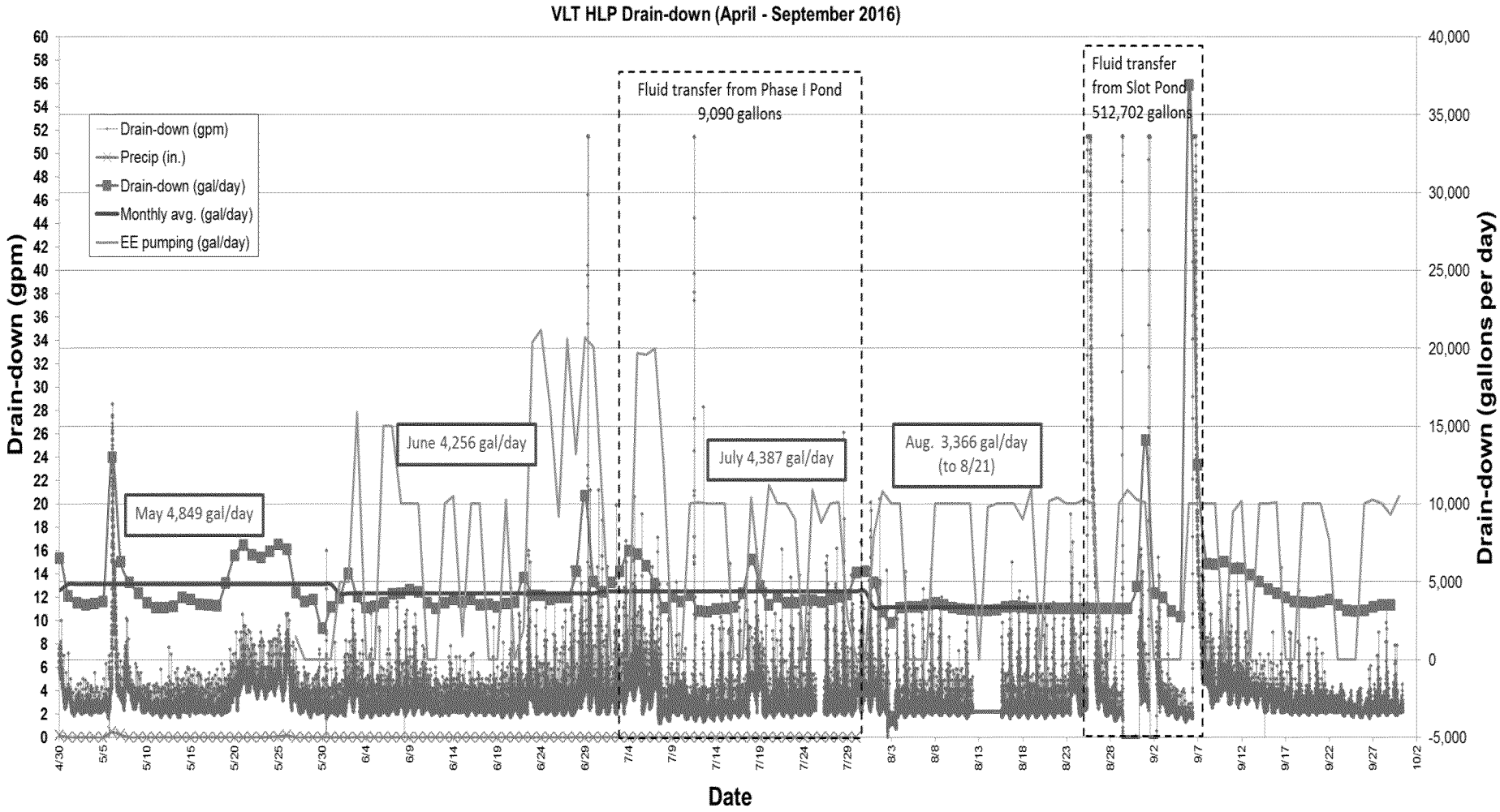
# Summary of weir flow data
*(see hard copy)*

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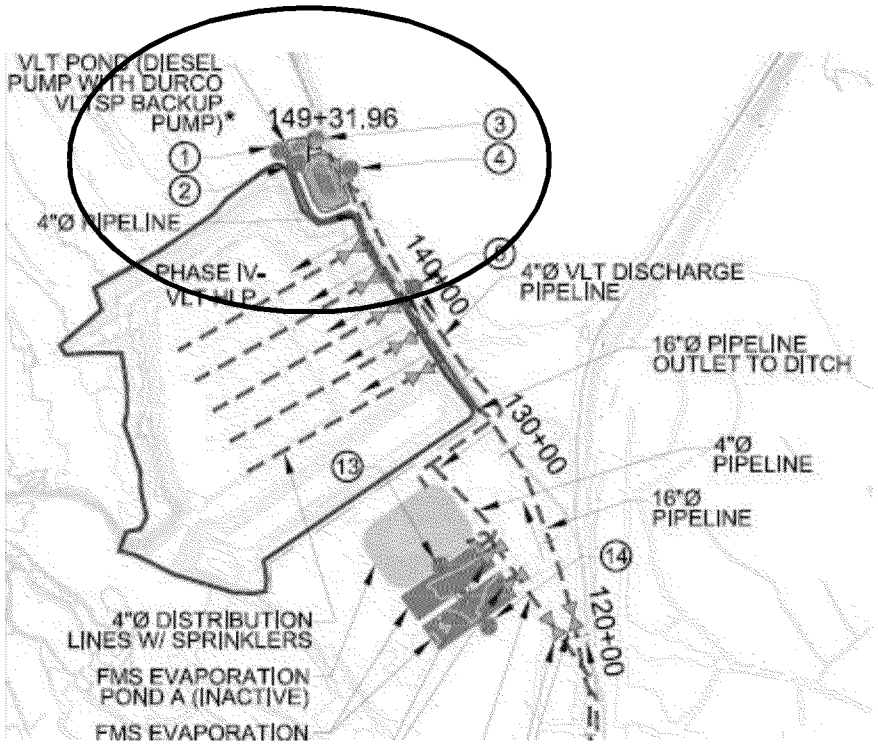
# VLT leak detector data




| LEAK DETECTOR ID | LOCATION |
|---|---|
| ① VLT D1 | DITCH BY WEIR NORTH |
| ② VLT D2 | DITCH BY WEIR SOUTH |
| ③ VLT SP | SEDIMENT POND |
| ④ VLT P1 | VLT POND |

- VLTD1, VLTD2, VLTSP have some fluids present
- VLTP1 and VLTD3 always dry
- Over past 2 years:
  - Decreasing trend over time
- No apparent correlation with:
  - Precipitation
  - Fluid transfers
  - EE pilot

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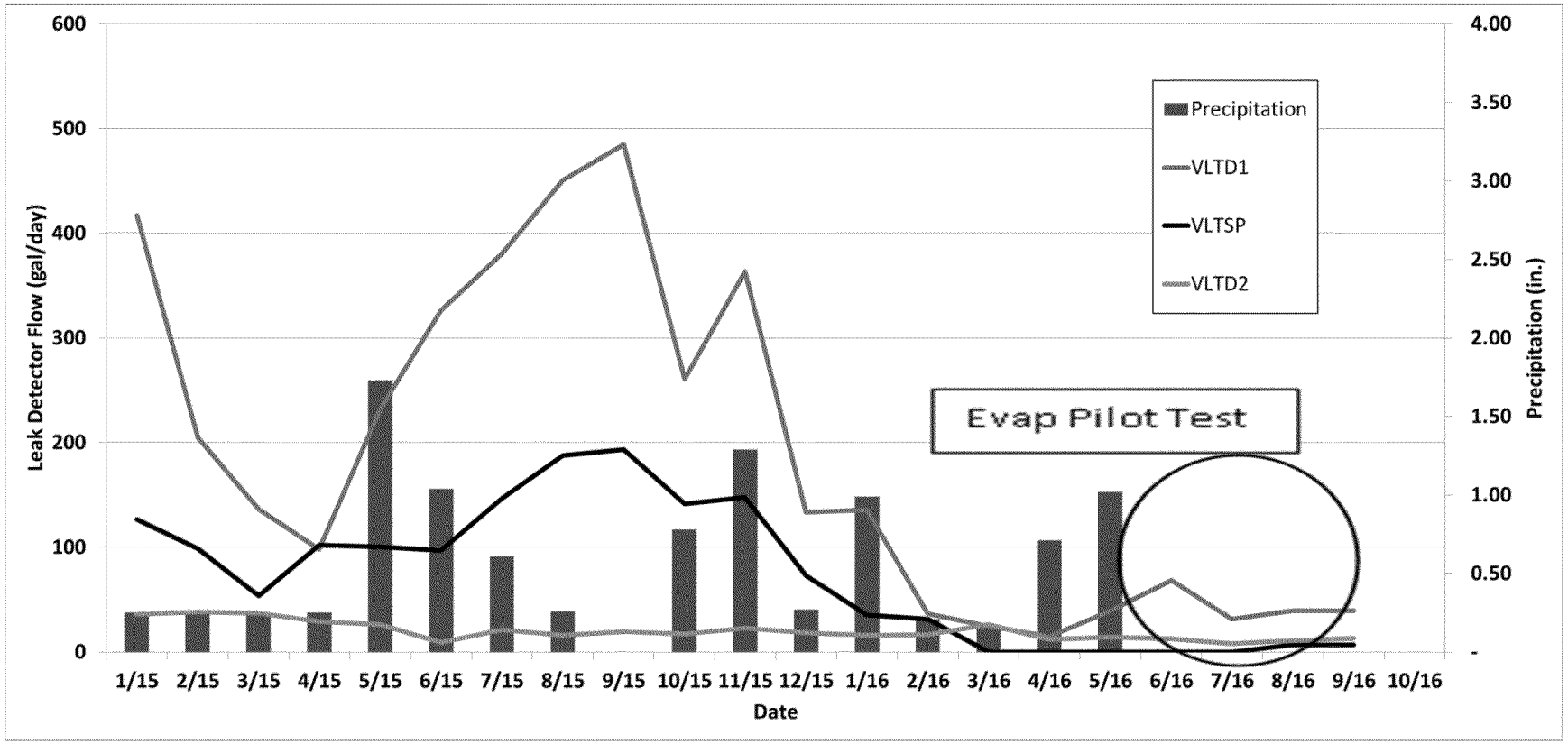


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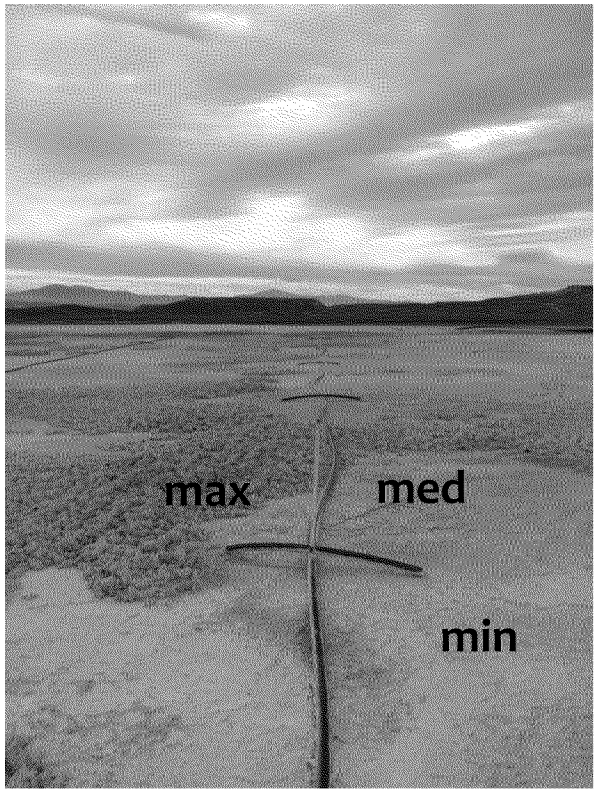
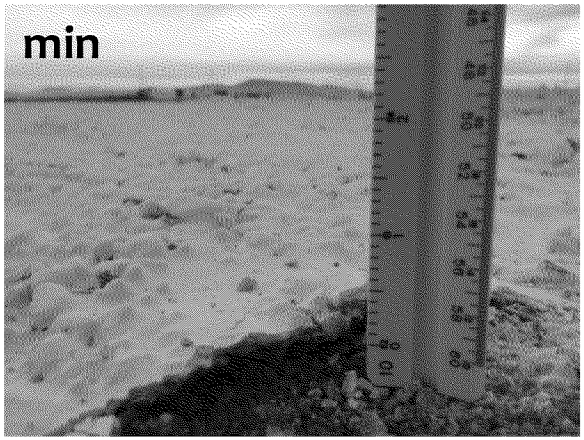
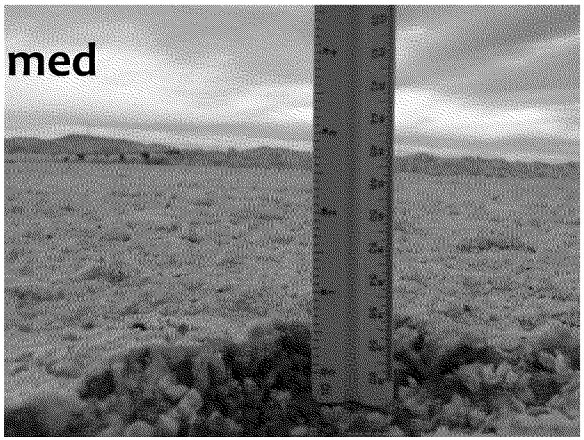
# Total dissolved solids

- From ARC data (VLT pond)
  - TDS ranges from 150,000 to 300,000 mg/L ("avg." ~225,000)
  - TDS increases with depth
  - Varies with time of year
  - Minor effect on EE pumping pressure and flow rate
- Solids Removal
  - 940,000 gal x 225,000 mg/L
  - 1,765, 000 lbs (884 tons) solids removed
  - Density of solids 127 lb/cu ft (est. from cement copper studies)
  - 104,000 'gal' of solids removed
  - Represents ~ 2.5 inches of solids on top of the HLP over the area of the pilot test
- Further evaluation using future TDS data

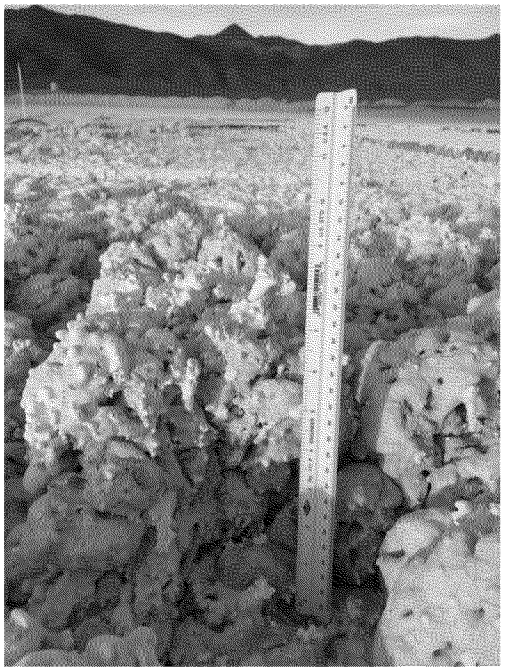
# Solids on surface of VLT HLP




max



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# Estimate of evaporation

- Measured rate of fluid application
  - Flow (gpm)
  - Volume over area (gal/ft^2)
  - Convert to inch/day
- Key Variables
  - Precipitation effects – no precipitation during pilot test
  - Other weather variables (temp, wind, humidity, etc.)
  - Surface area of pond
  - TDS variations (with depth and location)
  - others

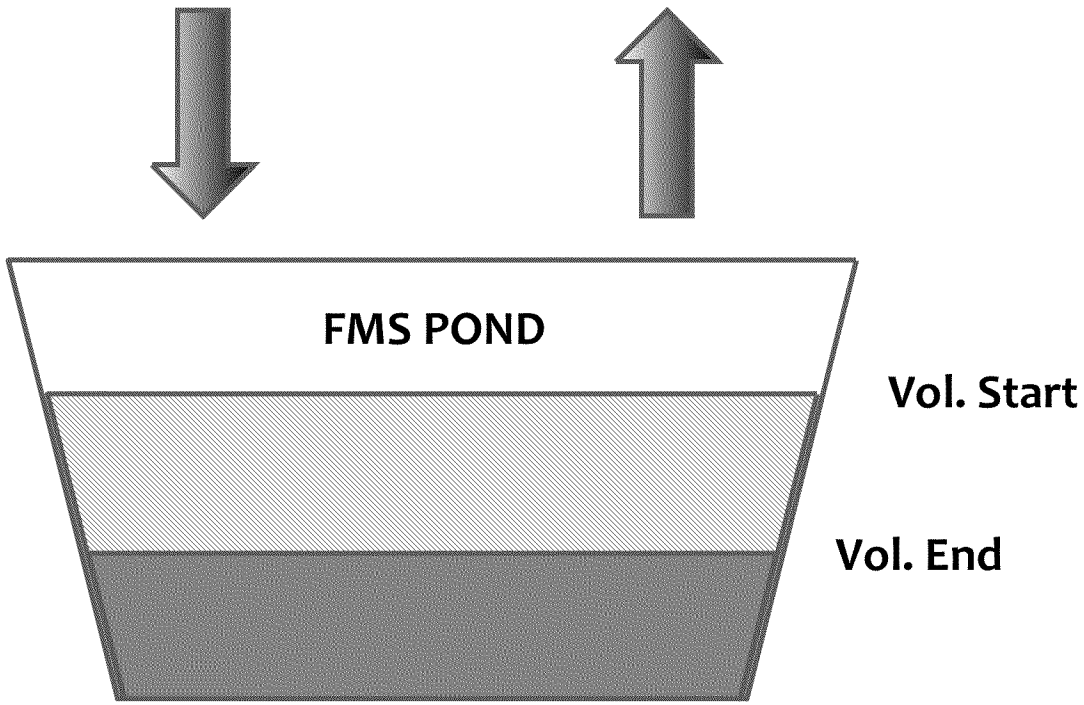
# Estimate of evaporation (cont.)

**INFLOW**

+ *Draindown (weir flow)*
+ *Precipitation (none)*

**OUTFLOW**

− *Enhanced Evap*
− *Natural Evap*

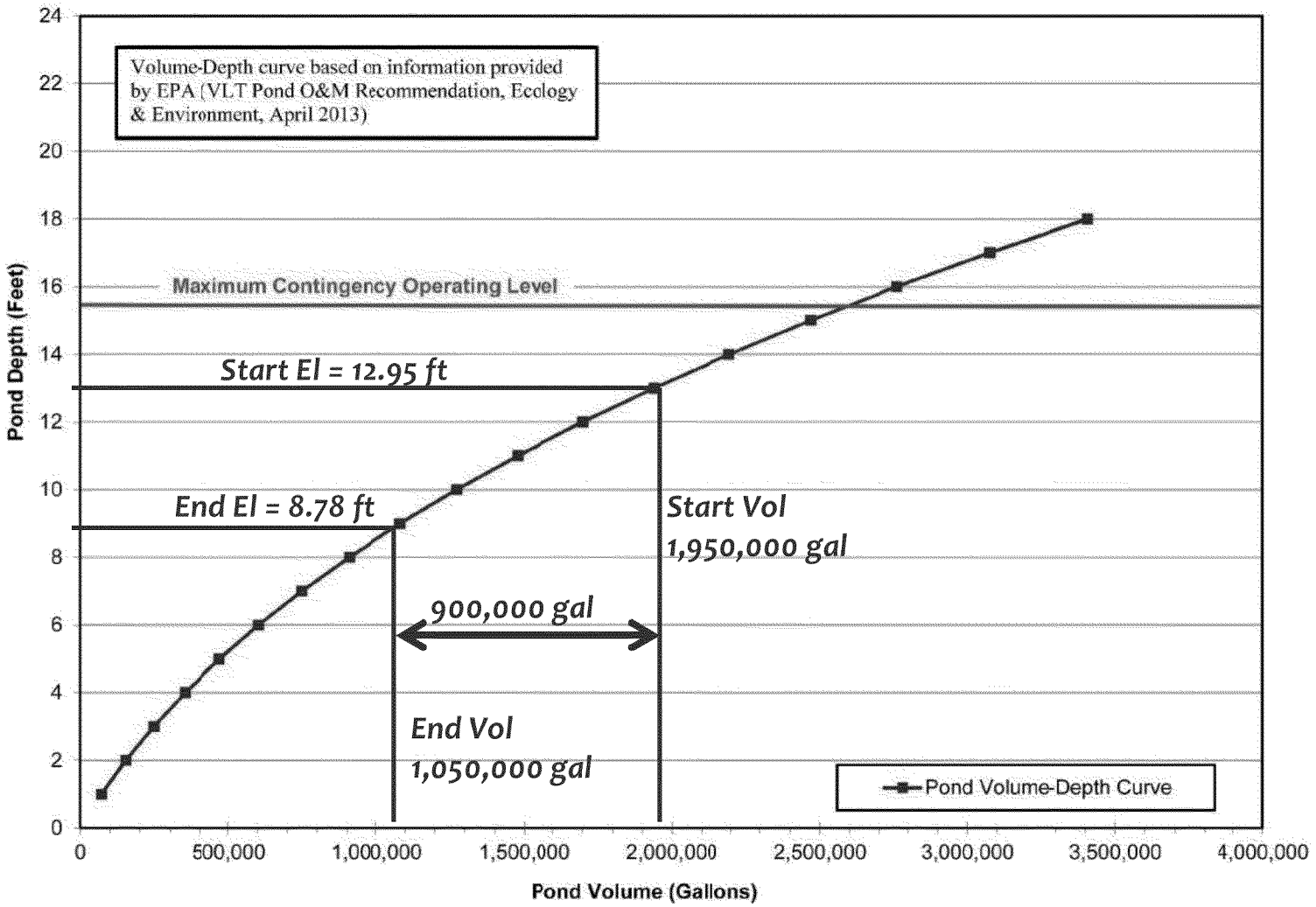



Start Vol + Inflow - Enh Evap - Nat Evap = End Vol

preliminary for discussion – final results will be provided in the final report

# VLT Pond – elevation vs. volume

*Between May 27 & Aug 19, 2016*

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# Estimate of evaporation (cont.)

Start Vol + Inflow - Enh Evap - Nat Evap = End Vol

| Parameter | Source/Comment | Jun 1 thru Aug 19 | |
|---|---|---|---|
| VLT pond start volume (gal) | From pond el/vol curve | 1,950,000 | |
| Inflow (gpm) | Measured from weir inflow | 315,699 | |
| | Precipitation - none | - | |
| | Recirculation | - | |
| Total VLT Fluids | Total VLT fluid, by addition | 2,265,699 | |
| VLT pond end volume (gal) | From pond el/vol curve | 1,050,000 | |
| Fluid Evaporation | Calculated by difference | 1,215,699 | |
| Outflow (gpm) | Enhanced evaporation | 662,450 | 54% |
| | Nat Evap, calculated by difference | 553,249 | 46% |

*From May 27 through Aug 19, prior to transfer from slot to VLT pond*

# Full-scale considerations

- Design & Operating Criteria
  - Full-scale system to achieve 1.5 – 2.0 M gal/yr
  - Area = 1.5x to 2x pilot scale (VLT and/or Slot HLP)
  - 15,000 to 20,000 gal/day (0.125 in/day)
  - 180 to 240 gpm
  - 4 mo/yr, 5 day/wk, 1.5 hr/day (80% run time)
- Key issues and mitigation
- Capital and OMM costs

# Full-scale system - key issues & mitigation

| Issue | Mitigation |
|---|---|
| Rate of fluid application (system size) | 0.125 in/day, 2x pilot scale |
| Clogging of nozzles/sprinklers | Pilot demonstrated clogging not an issue |
| Blinding of HLP surface | Beneficial; allows for more surface evap |
| Overspray | Shut down during excessive wind |
| Precipitate creates dust on HLPs | Verified does not dust (also Pond A) |
| Accessibility to top of HLPs | No issue |
| Stability of HLPs | Evaluation by SRK ok , no signs of instability |
| Operatorship of EE system | SPS operated pilot; potential full-scale TBD |
| Potential recirculation | Control fluid application rate; liners present beneath HLPs |
| Total dissolved solids (TDS) buildup in ponds | Removal of solids from FMS beneficial; potential EE effects on TDS ongoing, anticipated to be minor |

# Full-scale system - estimated costs

- Capital costs = $100k
  - Grading ($10k)
  - New main pump ($25k)
  - New piping/valves (25k)
  - Sprinkler heads ($5k)
  - Electrical ($5k)
  - Contingency ($30k)
- OMM costs ($150k/yr)
  - 2 FTE operators, 5 months ($80k/yr)
  - Engineering support ($25k/yr)
  - Reporting ($25k/yr)
  - Contingency ($20k)

# Enhanced evaporation - conclusions

- Pilot was successful in collecting empirical data for design of a full scale system:
  - Extend the life of the FMS by 10 yr
  - No net accumulation of fluids (est 1.5M gal/yr)
  - Low maintenance
  - Cost effective
  - Could be scaled to eliminate all fluids as part of long term remediation of ponds
- Additional considerations
  - NPL site remediation (EPA & ARC)
  - Alternative site remediation (NDEP & ARC)
  - Ongoing mineral exploration & development (SPS)